

Remarks

It is possible to find support for all the claims retained in the foregoing Amended Claims in the original provisional patent 60/057,180 filed in your office August 20, 2000 as well as in the body of the non-provisional patent application serial number 10/057,180 so no new matter is involved. Remarks therefore shall be confined to these two sources. Several claims were amended to reflect that present in the body of 10/057,180 such as crossing out "ranging from C3 to C15 in carbon numbers". The body of 10/057,180 in [0028] mentions the possible restriction in upper boiling range for liquid hydrocarbon feedstreams, as well as indicates a conservative boiling point corresponding to C15. Actual upper boiling point restriction is unknown at this time and any projection should be indicated conservatively only in the body of 10/057,180. Experimental data, operating with higher boiling feedstocks, and with a regenerator having a significantly reduced residence time in the possible carbonaceous formation portion of the final desorption zone as the invention can only establish the higher boiling point restriction limit.

Claim 3 has been Canceled so items 3) and 4) are no longer applicable as to "new matter". Therefore, the remaining terms that you mentioned as possibly new matter; item 1) "cool-down zone" in the regenerator, and item 2) "terminal adsorption stage" in the adsorber, not only are in the original provisional patent filed, but the body of 10/057,180 well defines the items clearly as follows:

1) For "cool-down zone", the Summary of Invention [0024] begins "The regenerator has at least a first desorption zone, a second desorption zone, and a cool-down zone." Regenerator Section [0064] also states in the third sentence "Regenerator vessel 174 includes a first desorption zone 176, a second or final desorption vessel 178, and a cool-down zone 180."

2) For "terminal adsorption stage", the Summary of Invention [0019] begins "The first upright adsorber vessel is optionally but preferably constructed in a plurality of sequential adsorption stages in descending order from a terminal adsorption stage to a feed entry stage." Detailed Description [0042] states in the second sentence "The fresh feed entry stage 110 is serially followed by a second adsorption stage 112, a third adsorption stage 114, a fourth adsorption stage 116, and a terminal adsorption stage 118." The writer chose to use stages for the adsorber and zones for the regenerator to facilitate better understanding. Although "last" and "final" sometimes describe "terminal", no attempt was made to change such wording if the intent of the claim is clear.

Some claims did require clarification and a sincere attempt was undertaken to claim more distinctly the subject matter regarding the invention. Claims 8, 9, 19, and 29 have been canceled as unimportant.

US Patent 5,730,860, now owned by the writer, uses liquid fluidized adsorption beds similar to application 10/057,180. Gas cross-flow also is used in the desorption of the spent adsorbent and cool-down of the hot desorbed adsorbent solids leaving the final adsorption zone so similar clauses might appear. However, there are distinctive clauses in Claim 1, the basic claim, that are unique to 10/057,180 over any stated in US Patent 5,730,860.

US Patent 5,730,860 Illustrative Example only provides a conservative estimate regarding liquid fluidized bed expansion for a full boiling range FCC feed. Stated in column 12, commencing line 10 "In adsorber vessel 16, the upwardly flowing liquid hydrocarbon...., under normal design conditions, is such that the adsorbent bed expansion in each adsorbent stage 30-40 is between 8% to 16% of the volume occupied by the adsorbent in each stage absent the upward flow of hydrocarbon liquid." Subsequent actual testing with such a full boiling range FCC gasoline in an Irvad pilot plant constructed later showed no benefit from operating in this bed expansion range and that adsorbent bed inventory was significantly much more important. The Illustrative Example was taken from work done for internal cost estimating for a typical commercial plant. The writer knew that bed expansion characteristics required for liquid phase adsorption had to be established experimentally together with liquid-solid fluidized phase adsorption stage performance simulating countercurrent movement of the adsorbent to fresh feed.

A section of glass tubing, the same diameter as the longer, lower section of metal tubing was installed in each of the Irvad pilot plant adsorber stages for fluid-solid level observation. Bed expansion characteristics of any adsorbent used could therefore be established for a given feedstock early. Glass tubing permitted observing changes in bed expansion that occurred from initially fresh adsorbent to being regenerated a number of times and bed particle movement. After several runs to indicate bed expansion changes that might be expected, adsorbent inventory was added to each of the adsorber stages. Operation of the liquid fluidized stages was extremely smooth as shown by several subsequent runs operating with fluid-solid interface having 4 inches clearance from the top tangent of adsorber, without changing the initial feedrate or having any mishap.

Observation of the adsorbent particles showed top to bottom mixing became of less concern when feed rates were reduced to reduce bed expansion. The liquid fluidized solid particles showed the same local circulatory motion when operated at limited bed expansion rates. A transparent larger diameter tubing having the proposed gravity transfer to the lower stage was constructed later with the adsorbent recirculated to demonstrate that the proposed solids transfer between stages was practical in operation with fluids flowing and solids being withdrawn continuously. The same local circulatory motion of the particles was observed. Because the transparent plastic tubing used in the transfer demonstration device was not recommended for hydrocarbons; a clear, higher viscosity, more dense fluid was used for the flowing fluid. This indicates that the invention applied for may reduce impurities in other than hydrocarbon applications, such as chemicals or removing organics from water with the proper adsorbent, particularly when higher quality and reduced utilities are required. Hence, Claims 5, 14, 15, 16, 17, 18, 20, 22, 24, 25, 26, 27, 28 and 29 treat liquid feeds with impurities in general, including hydrocarbons, as do Claims 1 and 2. US Patent 5,730,180 only treats hydrocarbons.

The limit on bed expansion discovery is reported in the 10/057,180 under [0053], and hence stating the restriction on bed expansion in the third clause of Claim 1. Staging is related to the top to bottom mixing that occurs in fluidization. Higher bed heights that increase the adsorber vessel utilization and decrease the cost of the adsorber for a given adsorber adsorbent inventory might now be practical. Knowledge from liquid-solid fluidization studies that particle size segregation might occur if narrow particle size ranges are not utilized i.e. small particle sizes

migrate towards the upper portion of a tall fluidized bed while larger particles migrate towards the bottom portion. Hence, the unique stipulation of a narrow particle size range being required in the third clause. Claim 2 is amended to teach the meaning of narrow particle size range and what particle mesh sizes are preferred. This teaching is not in US Patent 5,730,180.

Essential regenerator conditions required by 10/057,180 are given in the sixth clause of Claim 1. Such a stipulation enables fewer heat exchangers in the regenerator than US Patent 5,730,860. This may be seen by comparing the figures given for the regenerator in US Patent 5,730,860 with that of 10/057,180. Because of the significant temperature difference stated in Claim 1, hot effluent from the final zone may supply the heat required for heating the recirculating gas entering the first desorption zone and only a less expensive electrical heater is required for startup. Operating costs are overall lowered with the new 10/057/180 concepts compared to any claims or teaching in US Patent 5,730,860.

Clauses which indicate limited amounts of gas makeup to the regeneration section differs from US Patent 5,730,860 which requires significant reactivating gas makeup to cool the hot solids regenerated and provide sufficient inlet gas to the final desorption zone to accomplish sufficient removal of the impurities. Its teaching is primarily based upon refinery available hydrogen streams, such as the catalytic reformer hydrogen stream, to cool the hot regenerated solids leaving the final desorption zone and route the leaving hydrogen gas streams to downstream hydrogen consuming units.

Hydrogen is not essential to the process. For example, nitrogen normally was employed in the Irvad conventional batch regenerated pilot plant, and only tested hydrogen briefly because of the expense. Therefore, the statement of limited reactivating makeup in Claim 1 as well as teaching how it may be achieved with an illustrative figure is not only distinctive but may be considered an advancement in the art of treating. Less dependence upon other units is a refiner's desire if it's economic. Claim 15 indicates the order of what is probably practical.

A number of other advantages occur in 10/057,180 over US Patent 5,730,860. First, the apparatus shown has more flexibility and is easier to control. Second, it affords an octane quality improvement for the adsorber treated product for certain feedstocks, such as FCC gasoline. The ability to recycle the liquid derived from the first desorption zone to the latter adsorption stages is important. The sulfur content of the first desorption zone contains below 10 % of the feed sulfur content and less than 2% of the feed nitrogen content providing the temperature of the solids leaving the first desorption zone is not excessive. Liquid recycle derived from the first desorption zone to the latter stages of the adsorber improves the octane quality of the adsorber treated product because aromatics and olefins, which have higher octane than the saturates in the feed, preferentially enter the spent adsorbent pores. Recycling for such feedstocks improves the yield of the adsorber treated product on feed with only a slight increase in adsorbent circulation. For US Patent 5,730,860 adsorbent circulation increases for otherwise constant conditions as the sulfur content of the treated product is lowered. Because blending off the liquid derived from the first desorption zone is not permitted below a certain product sulfur level, yield on feed and octane of the adsorber treated product suffer and the amount of liquid from the regenerator to downstream processing increases. Liquid recycle of 10/057,180 eliminates this low sulfur

content drawback for gasolines inherent in US Patent 5,730,860.

The other claims not mentioned are dependent upon Claim 1 directly or indirectly. It should be apparent that whatever was achieved in the pilot plant based upon US Patent 5,730,860 can be achieved more economically with 10/057,180 teachings.